Mission report of the CIRAD (UR GECO) team to Lao PDR
from 17/10/17 to 24/10/17

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MISSION OUTLINE

- 19-20/10/17 - Very instructive and stimulating meetings with NAFRI, HRC, and PPC that highlighted the major issues associated with banana production in Laos.
- 20-23/10/17 - Field visits of banana export farms and smallholders farms in the region of Vientiane and Oudomxay.
- 24-26/10/17 - Institutional meetings with FAO, AFD, French Embassy, Helvetas, Gret.

MAJOR OBSERVATIONS

Banana production for export

- Export banana farms are using a huge quantity of pesticides that represents a great danger for health and environment. We confirm that pesticides are used without following any cogent management (unsuitable mixtures, doses, application modes…). The application of pesticides is particularly harmful for workers and their family; it is unseen elsewhere in other banana export production areas worldwide.
- We observed a huge incidence of Fusarium Wilt that is due to *Fusarium oxysporum f.sp. cubense* tropical race 4 (TR4) on Cavendish bananas cultivated in export banana farms. The real new information is the importance of the outbreak: a significant area (likely thousands of hectares) appeared to be affected by the disease, although we were not able to carry out a complete evaluation of its dissemination. Observations from the field evidences that the outbreak is currently in its exponential phase. In the absence of any program of surveillance and containment, TR4 will likely spread throughout the country.

Banana production for local market

- Farmers growing banana for local market are facing numerous phytosanitary and durability problems. There is a high risk that practices based on pesticides will rise in the coming years (partly by copying banana export systems). This is a country-wide threat for health and for environment.
- These smallholders systems began facing the TR4 and this is likely to increase dramatically in the future. Altogether, TR4, other phytosanitary problems, and soil health issues constitute a threat for the sustainability of local banana production and potentially for food safety and nutrition.

PROPOSED WORKING PLAN AND RESEARCH/DEVELOPMENT AGENDA

Banana production for export

- Diagnostic of the environmental and sanitary impact of banana export plantations in Laos (including the evaluation of the potential of risk based on practices analysis and the evaluation of the impact on the environment and workers health).
- Strengthen the knowledge of provincial and district administration for pesticide risks and safer pesticide use.
- Disseminate the sustainable cultural practices (proved to be highly efficient to reduce pesticides applications and to improve yield, as already adopted in other regions of the world).
- In cooperation with PPC (Lao Plant Protection Center) rapidly map the extent of TR4 dissemination within the country and at its borders.
- Set up clear rules for disease containment in areas where it has been detected in order to avoid/delay contamination of new uninfected areas.
- Develop strategies to cope with TR4 in banana production in new areas and banana production for local markets.

Banana production for local market

- Design with farmers cropping systems that increase their sustainability, especially regarding the pests and diseases threat. This should be done without using chemicals but rather with efficient cultural practices and a smart use of biodiversity. Such systems should i) improve their resilience to pests and diseases (including TR4) and to climatic variability, and ii) participate to the food and nutrition safety.

Context of this mission

Cavendish intensive banana production has started only recently in Lao PDR (early 2010) in Northern provinces through a partnership between Lao PDR and Chinese governments. This production relies on land concessions to Chinese investors for several years mainly on a '1+4' policy where a farmer rents its land and the investor brings financial investment, labor, technical management and market access. Chinese investors are attracted in Lao PDR for several reasons:

- Banana demand in China is increasing while at the same time Chinese production is declining (higher incidence of diseases like TR4, higher restrictions in the use of agrochemicals)
- Low land rental fee and low labor costs

Banana cultivation has grown rapidly (around 23000 ha and 270 000 tons from which 90% were exported to China in 2014) using technologies introduced by Chinese investors. Very soon, health problems and environmental pollutions have been reported. At the demand of the Ministry of Agriculture, NAFRI, through the AFPRC, conducted a survey in 2016 to evaluate the sustainability of this banana production. This study has documented the problems generated by this intensive cultivation of bananas in terms of social impacts, not only for economic issues but also on sanitary and health consequences for workers and local populations. And additional study conducted by IMWI has confirmed water and soil pollution by several pesticides. More recently, during the 2017 Agriculture exhibition in Paris, the Lao PDR Ministry of Agriculture has contacted the General manager of CIRAD to obtain a technical assistance to manage this situation, knowing Cirad's background on pesticide reduction in banana cropping systems (particularly in the FWI). This demand has been the starting point of this mission of the members of the direction of the Cirad's research unit GECO (Ecological Functioning and sustainable management of banana and pineapple agrosystems). The objectives of this mission were to better understand these issues and to identify possible collaboration themes with NAFRI in order to mitigate environmental negative effects of banana cultivation and to promote more environmental friendly cropping systems. This mission has been organized with the assistance of Philippe Girad (Regional Director for CIRAD in South-East Asia) and the strong implication of Isabelle Vagneron (CIRAD, based in AFPRC and formerly implied in NAFRI's survey).

Program of the mission

19/10/17 : meeting in NAFRI with Isabelle Vagneron (CIRAD, UMR MOISA, based in AFPRC)

- Dr Bounthong Bouahom, Director General of NAFRI
- Dr Bounneuang Douangboupha, Director of Horticulture Research Center/NAFRI
- Vongpaphane Manivong, Director of AFPRC/NAFRI
- Khamlar Sengphaxayalath, NAFRI

20/10/17 : Field visits with Khamlar Sengphaxayalath, NAFRI

- Fruit market in Vientiane : observation de la diversité des bananiers commercialisés sur la zone de Vientiane
- Visit of Horticultural Research Center, with Dr Bounneuang Douangboupha, Director of Horticulture Research Center.
- Visit of a local banana farm in south Vientiane
- Visit of Plant Protection Center with Thiangkham Vongsabouth, director
- Meeting with Pascal Lienhard (CIRAD, UR AIDA)

21/10/17 : Field visits with Khamlar Sengphaxayalath, NAFRI

- Visit of a chinese Cavendish/export banana plantation (35-50 ha, 200 m) in North-West Vientiane, Songthong district with local DAFO representative.
- Meeting withc Philippe Cao Van (CIRAD, UR AIDA)

22/10/17 : Transfer to Louang Prabang and Oudomxay (Khamlar Sengphaxayalath, NAFRI, Isabelle Vagneron)

23/10/17 : visits of banana plantations in Oudomxay province (Khamlar Sengphaxayalath, NAFRI, Isabelle Vagneron)

Visits of 2 chinese banana plantations (farm 1 et farm 2) in Houn district, close to Lan Ting village (370 ha et 53 ha, 460 m) with local DAFO representative

24/10/17 : visit of a banana plantation (Khamlar Sengphaxayalath, NAFRI, Isabelle Vagneron)

Visit of a chinese banana plantation around Muang Xay close to Ban Mai village(25 ha, 770 m) with local DAFO representative

25/10/17 : institutional meetings

- Meeting in AFD (Ventiane) - Morgane Cournarie (in the absence of Mathieu Bommier, representative of AFD in Lao PDR).
- Meeting to FAO - Stephen Rudgard, representative of FAO in Lao PDR.

26/10/17 : institutional meetings

Meeting with Andrew Bartlett (Laofab)

Meeting with an NGO (GRET)

27/10/17 : institutional meetings

Meeting to the French embassy in Lao PDR (Vientiane), Fanny Gazagne, cooperation attaché

Main observations during this mission

Our field visits do not claim to give an exhaustive description of banana production in Lao PDR as for instance the former study conducted by AFPRC, NAFRI and MAF in 2016 on "Sustainable commercial agricultural production: a case study of commercialized banana production in Lao PDR"; the study conducted by IWMI on environmental risks from commercial banana farming in Northern Lao PDR; or the survey on TR4 presence in Lao PDR initiated by the PPC.

As specialists of sustainable banana cropping systems, our contribution is aimed at giving a complementary analysis of banana production in Lao PDR from our personal observations during this mission and our knowledge of banana production in other contexts.

I. Outlook of bananas present in Lao PDR

Cavendish bananas (kuay Hom, also Kuay ngao, *Musa acuminata*, AAA) are largely cultivated in the 3 northern provinces (Phongsaly, Oudomxay, Luangnamtha) mainly for exportation to China. Cavendish bananas represent about 23000 ha and have been cultivated very recently (since 2005) at this large commercial scale. Some new banana farms are now expanding in the center of the country (including the Vientiane province) from Chinese investors, but also in the Southern part on the country (from Vietnamese investors).

As we could observe in the Vientiane fruit market, **Cavendish bananas are not much commercialized on the lao local market**. Two other types of bananas are mainly grown and sold locally (see photos):

- The **most common is the "Kuay nam" banana variety**. This banana is from the Pisang Awak group (ABB). It is considered as very rustic and is given as resistant to fungal leaf spot diseases. This is probably the reason why it is so largely present on local markets.
- A second type is another flavored banana also called Kuay lep mue (also Kuay hom), belonging to the AAB group (Lady finger or Figue pome). This type of banana is much appreciated but susceptible to fungal diseases like Panama disease (Race 1 and TR4).

Kuay nam bananas (Pisang Awak group, ABB) on a local market in Vientiane

Kuay lep mue (hom) banana (AAB type) on a local market in Vientiane

Kuay lep mue (hom) banana (AAB type) in a smallholder plantation near Vientiane

Even if we could not make during our mission a comprehensive evaluation of the banana diversity in Lao PDR, our feeling is that more genotypic diversity was present in Oudomxay province (out of the commercial plantations of Cavendish bananas) than in Vientiane province.

II. Outlook on banana diseases present in Lao PDR

During our field visits we could notice the presence of several important diseases of bananas. We did not evaluate the presence nor the importance of pests mainly because they require specific methods that could not be performed during a so short mission. The most important observation is about the presence of *Fusarium oxysporum* fsp cubense tropical race 4 (TR4), responsible for a serious Fusarium wilt on bananas also called Panama disease.

1. TR4 an important threat to banana production in Lao PDR

In the past, *Fusarium oxysporum* fsp cubense was already present in Lao PDR, but only race 1 was present in the country. Race 1 is not pathogenic to Cavendish bananas but is pathogenic to Lady finger bananas (Kuay lep mue, AAB) and also on other AAA triploids like Gros Michel. TR4 is a new emergent pathogenic disease on Cavendish bananas and also on other bananas present in Lao PDR (Kuay lep mue/AAB and Kuay Nam/ABB). This disease has been reported before in Lao PDR, and PPC conducted a survey which confirmed its presence in the country, mainly in the province of Luang Namtha and also close to Vientiane in Viangvieng district. The introduction of TR4 in Lao PDR is probably due to the development of Cavendish banana production from China where this disease has been reported before (since 2004), particularly in the southern province neighboring northern Laos.

During our visits **in the Oudomxay province we have noticed a very high prevalence of TR4** in two Chinese banana plantations in Houn district, close to Lan Ting and Muang Houn. Most banana plots of these two farms were affected at a high level (conversely to farmer's declaration in thge first

farm). Some plots were already totally destroyed and the farmer destroyed them with Paraquat (a banned herbicide in Lao PDR). Moreover, we could also easily observe important symptoms in most Cavendish banana farms on the road between Muang Xai and Houn district. This shows that TR4's expansion in Oudomxay province is very important. **This was not reported before, even during PPC survey**. This expansion is probably important in the three northern provinces close to south China: Luang Namtha, Phongsaly and Oudomxay. In both the farms we visited, the disease has been reported quite rapidly (after 2 years of cropping) which shows that its dissemination is very fast, probably through anthropic factors. The disease might have been intensely propagated through infected soil/water movement linked with the establishment and functioning of the banana farms : circulation of vehicles from infected farms to other farms (trucks, cars, agricultural machinery for land preparation, ..), circulation of workers (soiled shoes). No specific measures are currently taken by farmers who likely go on propagating the disease inside their own farm and elsewhere as for instance between or in other farms.

Our expectation is that **growing Cavendish bananas in these provinces will shortly be restricted by TR4 for a very long period** (infective fungal spores remain in the soil for more than 30 years and the causal fungus is able to survive on other symptomless infected plants). **The disease might also affect the production of local bananas (Kuay nam, Kuay lep mue) which are also susceptible to TR4**. The reported presence of TR4 in other provinces (Vientiane, but also in the south) shows that the disease is also expanding in the country, limiting Cavendish production and also being a serious threat to other banana varieties grown for the local market.

A Cavendish banana plantation highly affected by TR4 in the road between Muang Xai and Muang houn


Symptoms of TR4 on Cavendish bananas in a 5 years Chinese farm close to Lan Ting (Houn district)

Many banana plants of this farm are affected by TR4

A plot totally destroyed by TR4 in this farm, destroyed with Paraquat

Plants affected in a another 2 years banana farm in Houn district

2. Presence of Bunchy top

We have also **observed the symptoms of an important viral disease of bananas on Cavendish bananas at HRC: the Banana Bunchy Top Disease (BBTD)**. This disease is transmitted to bananas by an aphid, *Pentalonia nigronervosa*. The insecticides used in the commercial Chinese banana farms are probably targeted to the control of this aphid. BBTD might affect commercial plantations and the management of this disease might be challenging in Lao PDR. Our observation of BBTD symptoms deserves to be confirmed by viral analyses.

Presence of Bunchy top disease on Cavendish bananas located at HRC

3. Leaf spot diseases of bananas

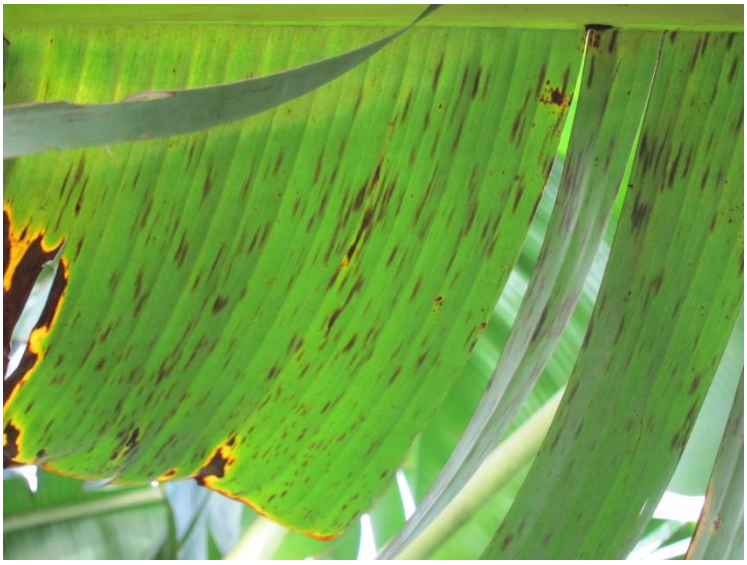
During our field visits **we could notice various other species of fungal leaf spot diseases, and sometimes several species were mixed on a same banana tree**.

- *Mycosphaerella musicola* (causal agent of Sigatoka disease or yellow leaf streak) was present alone in a smallholder farm of bananas intended for local market on Cavendish bananas in south Vientiane.

Symptoms of *Mycosphaerella musicola/Sigatoka disease*

- *Mycosphaerella fijiensis* (Black Leaf Streak Disease, BLSD) was present in most commercial Cavendish banana plantations in Vientiane province and Oudomxay province.

Black leaf streak disease in a Chinese banana farm in Songthong district (Vientiane province)



Black leaf streak disease in a Chinese banana farm in Houn district (Odoumxay province)

A third leaf spot disease has been observed in several places, often mixed with Black Leaf Streak Disease, and alone in a banana farm close to Muang Xay, located at a high elevation (770 m). This leaf spot is probably the Freckle disease caused by *Phyllosticta musarum*.

Freckle observed in a banana farm located close to Muang Xay

High incidence of Freckle in this banana farm

All these leaf spot diseases induce yield losses but also premature fruit ripening in the case of Sigatoka disease and BLSD. These diseases are currently tentatively targeted by fungicides used in the Chinese banana farms.

III. Outlook on pesticide use in Lao PDR

Generally it has been very difficult to obtain reliable information from the managers of the Chinese banana farms on pesticide use. Most information that we could verify objectively was not conform to manager's declarations. We apologize also that such differences might also be due to misunderstanding through translation.

However during our visits we could observe a pesticide application in the field and check some of the pesticides used in the Chinese farms. Our observations strongly consolidate the situation yet

evidenced in NAFRI and IMWI studies about the hazardous and unsafely use of pesticides in banana farms in Northern Lao PDR. Our objective here is to report here some concrete facts.

- **Various pesticides are used in mixtures. Fungicides and insecticides are mixed and abundantly sprayed until consistent run-off on the banana plants**

Insecticides and fungicides are used for plant spraying in complex mixtures. The farm managers we interviewed had only a vague explanation of the purposes of these sprays. Leaf spots control was mentioned but also TR4 inexplicitly in farm 2 in Houn district (however it is well known that such treatments are fully inefficient for TR4 control !). It has been very difficult to know exactly the frequency of such applications but it seems that applications are more or less on a monthly basis and not linked to any pest or disease decisional indicator. **Applications are rather decided on a systematic and intensive basis to avoid any putative risk of disease**.

All pesticides that we have observed came from China. All inscriptions on the packaging were in Chinese language. However we could identify most products used from their references.

Pesticides used for plant spraying in Farm 1 in Houn District

In this farm we had the opportunity to pe present during a pesticide application. **A mixture of at least 7 different products was used for plant spraying**. We could identify at least three products as an insecticide (imidaclopride) and two systemic funcicides (Pyraclostrobin belonging to the QoI group, difénoconazole belonging to the DMI group). Two products were probably oligoelements used for plant nutrition (grey flasks). Two could not be identified at this stage.

Mixture of at least 7 pesticides used for plant spraying in a farm1

One of these products is an insecticide: imidaclopride

One of these product is a fungicide : pyraclostrobin


One of these products is a fungicide : difenoconazole

Pesticides used as plant sprays in Farm 2 in Houn District

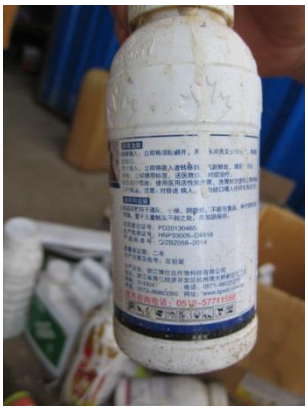
The products used in this farm are different (commercial names) from the products used in farm 1 even if the active ingredients are sometimes the same. In this farm a same active ingredient is also used under different commercial names. Many different fungicides are used in mixtures in this farm. **We have identified at least 6 different products**. Contact fungicides like chlorothalonil and systemic fungicides like (i) difenoconazole (DMI group), (ii) a mixture of difenoconazole + thifluzamide (DMI + SDHI groups), (iii) pyraclostrobin (QoI group), and (iv) fluxapyroxad (SDHI group). Here products which have the same effect because they belong to the same group (thifluxamid and fluxapyroxad) or because they have the same ingredient (difenoconazole and difenoconazole + thifluzamide) are mixed which show that the managers do not really know the products. In other words **there is no technical requirement to use such mixtures of fungicides**. **Such fungicide use is intensive and abusive**.

Mixture of at least 6 pesticides used for plant spraying in a farm located in farm 2

One of this product is a fungicide : chlorothalonil

Chlorothalonil is worlwide recognized as quite toxic and harmful to workers.

One of this product is a fungicide : difénoconazole



One of this product is a mixture of fungicides : difénoconazole + thifluzamid

One of this product is a fungicide : pyraclostrobin

One of this product is a fungicide : fluxapyroxad

Other pesticides used in these banana farms

We had no information about the use of herbicides except the mention of the use of paraquat for destroying TR4 affected plots. As a reminder, Paraquat use is not permitted in lao PDR. However, in all plantations the ground was never found to be covered by weeds and we could observe wilted ~~plants~~weeds? consecutively to the use of herbicides that was obvious in all farms visited.

Paraquat is officially banned in Lao PDR as reminded in PAFO offices

Evidence of herbicide use in a Cavendish banana farm located in Houn district (Oudomxay province)

- **Pesticides are generally applied in very inappropriate and unsafe conditions and lao workers and their family are totally unprotected**

Pesticides are applied in very hazardous conditions for workers:

- Workers are not properly protected during spraying operations
- Spraying operations are dangerous for the worker directly in charge of spraying operations because of important run-off of the pesticide mixture falling down on the worker
- Spraying operations are dangerous for workers (often women) moving the long flexible set between the motor pump and the spraying nozzle (more than 100 m). Children may asleep in the back of their mother during this operation and are dangerously exposed to the chemicals.
- Workers in charge of mixture preparations (exposed to pure products) do not wear any protection. Proportion of products in mixtures seems also vague and inaccurate.
- Important environment contamination occurs through consistent run-off during spraying operations but also because of leakage from containers or flexibles.
- Some chemicals used in such conditions are really hazardous for health. This is the case for insecticides (eg imidaclopride) and contact fungicides like chlorothalonil.

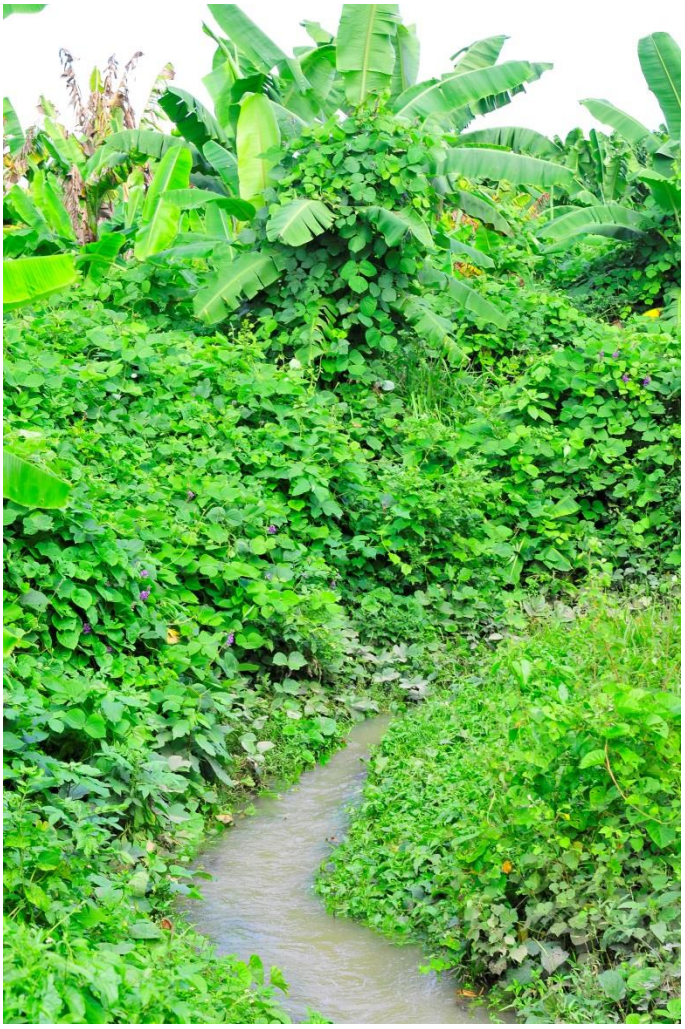
Workers are not correctly protected during spraying operations and are dangerously exposed to pesticides

Run-off is important leading to an important contamination of workers and environment

A woman in charge of flexible movement has a young baby on her back. Both are not protected at all and passively exposed to dangerous sprays

Workers in charge of mixture composition are not protected at all

Leakages can lead to important environmental contamination



The water flowing from banana farms are directly contaminated by pesticides drift and runoff

Fruits always exhibit important traces of pesticide applications

Children are directly exposed to pesticides

IV. Perspectives for the sustainability of banana production in Lao PDR

This mission was initially motivated by the problem of environmental pollution highlighted by former NAFRI studies. However during this visit we have highlighted the important spread of TR4 in the country that represents another important threat for banana sustainability in the country, for Cavendish bananas, but also for food safety in Lao PDR. We consider then that these two major problems should urgently be tackled in the country.

1. Actions to mitigate the environmental pollution?? in commercial banana production in Lao PDR

Even if there is now some evidence of the environmental and sanitary impact of banana commercial plantations in the country, this diagnostic must be further detailed. By another hand, a serious and extreme change in pesticide use is required in Lao PDR. Here is a list of actions that we consider as important to tackle this important problem:

1. Establish a fine tuning diagnostic of all practices/products used in banana commercial farms in order to clearly identify : the various products, the frequencies of pesticide uses, the different modes of applications, the various criteria used for pesticide use decisions (who decides which products and when). It is particularly important to better understand which are the key actors to target in order to reduce/rationalize pesticide use.

2. Complete this diagnostic through a broad evaluation of soil/water/workers contamination. Particular attention should be paid to the Mekong river that could shift environmental pollution to other regions where banana production is not present.

3. With the support of MAF, strengthen the knowledge of provincial and district administration for pesticide risks and safer pesticide use. Alternative good agricultural practices should then be defined and promoted as a first task. A second task would be the training of provincial and district administrations. Then farm managers, farm workers should be trained on these good practices.

4. Set up experimental plots in order to demonstrate how important pesticide use reduction can be achieved in the different provinces.

2. Actions for the TR4 management and sustainability of banana production in Lao PDR

The observed dissemination of TR4 in Oudomxay province suggests that the situation is probably as important (maybe even more) in the two other Northern provinces. The sustainability of banana production in such provinces is probably very low now because of a so important distribution of the disease. TR4 threatens now other provinces as shown by the recent observation of TR4 in commercial banana plantations in the Vientiane province in Viangvieng. Allthemore TR4 is now a real

threat for banana production and food safety in Lao PDR (even for local market). Here are some actions that we consider as important to tackle this problem.

1. With the support of MAF very quickly inform lao provincial and district authorities as well as extension services on this threatening disease and on its natural/anthropic ways of dissemination. This same information should also be directed to farm managers, land owners (they will be affected in the future for a very long time !) and workers since they play an important role in this anthropic dissemination.

2. In cooperation with PPC (Lao Plant Protection Center) rapidly map the extent of TR4 dissemination within the country and at its borders by completing an exhaustive survey to identify areas that remain unaffected and that should be protected from disease arrival.

3. Set up clear rules for disease containment in areas where it has been detected in order to avoid/delay contamination of new uninfected areas (quarantine and restriction measures to delay TR4 spread). Particular attention should be paid to soil and water movements linked to human or animal activities.

4. Develop strategies to cope with TR4 in banana production for local markets and in new banana plantations

5. Screen for resistance/tolerance of local varieties for local banana production.

3. Actions for the co-development of a sustainable production of banana for local markets in Lao PDR

Design with farmers cropping systems that increase their sustainability, especially regarding the pests and diseases threat. This should be done without using chemicals but rather with efficient cultural practices and a smart use of biodiversity. Such systems should i) improve their resilience to pests and diseases (including TR4) and to climatic variability, and ii) participate to the food and nutrition safety.

CIRAD is ready to put into play its expertise and assistance to launch all those actions (handling of pesticides and alternative good cropping practices, appropriate TR4 management) with the objective of building up and strengthening the capacities of the Lao stakeholders for promoting an agroecological and sustainable Lao banana production and protect local banana varieties. These actions could be tackled in the framework of cooperative R&D national and regional projects with the facilitating support of MAF, DOA and other lao services (AFPRC, NAFRI, PPC, …) and international institutional organisms such as FAO, AFD, Bioversity, ACIAR, NGO… ready to support Lao PDR actions in agriculture.